#2336

Biological Evaluation of Hemlock Sawfly and Black-headed Budworm in Southeast Alaska during 1973

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by
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Hemlock sawfly and black-headed budworm populations have in the past caused widespread defoliation of spruce-hemlock stands in southeast Alaska. The most significant outbreak on record occurred in the early 1950's when tree "browning" was reported throughout the Forest. Effects of defoliation include growth loss, scattered top-kill, and occasional tree mortality. The sawfly feeds on hemlock and the budworm feeds on both spruce and hemlock. Their combined feeding results in increased damage.

This report summarizes the status of sawfly and budworm populations and discusses briefly some forest management implications.

SURVEY METHODS

We depend considerably on reports from field personnel to locate unusual forest insect or disease situations. These reports were supplemented in 1973 with four types of surveys. First, larval samples were collected in early August at 118 locations in southeast Alaska to monitor sawfly and budworm population levels. Second, an aerial survey was conducted of those areas where either field reports or larval collections indicated defoliation that could possibly be visible from the air. Defoliation was sketch-mapped at a scale of 1: 250,000. The third survey involved sampling of sawfly and budworm eggs in areas of substantial defoliation. A fourth survey involved a re-examination of hemlock damage on permanent plots in the Ward Creek drainage near Ketchikan.

RESULTS

Larval Samples

Of the 118 sampling locations sampled in 1973, only 14 had sawfly or budworm counts of 40 or more (Table 1). High larval populations were concentrated on the east side of south Prince of Wales Island and on Revillagigedo Island.

Aerial Surveys

Locations having a known infestation potential were aerially surveyed on September 12. Approximately 13,000 acres of medium to heavy defoliation was observed on National Forest land south of Sumner Strait.

On the east side of Prince of Wales Island, defoliation was concentrated in the North Arm of Moira Sound, Port Johnson, Paul Lake, Dutch Harbor, Windy Point, Windfall Harbor, Karta Bay, Dora Bay, and the South and West Arms of Cholmondeley Sound. On Revillagigedo Island, sawfly feeding was conspicuous in Ward and Whipple Creeks, at California Head, and in Thorne Arm and Princess Bay. Most of the defoliation in 1973 is attributed to sawfly feeding. Budworm feeding contributed to the damage in some areas.

Ward Creek near Ketchikan was the most seriously defoliated area on the Forest in 1973. A total of 1,132 areas were defoliated in the drainage. An additional aid to identifying defoliated areas on Revillagigedo Island is color aerial photography taken between July and September, 1973, and which is currently available at a scale of 1: 15,840.

Egg Surveys

Although samples collected on October 23 and 24 revealed no hemlock sawfly eggs, there were sufficient budworm eggs to indicate light to medium defoliation in 1974 (Table 2).

Hemlock Mortality Plot Data

A re-examination was made of four 1/5-acre plots near Ward Lake and four 1/5-acre plots near Connell Lake in the Ward Creek drainage near Ketchikan. The data from these plots represent higher than average defoliation histories. The crown condition of trees on those plots may be examined in Tables 3 and 4. Many trees in defoliation class 4 have very few green needles and some of these trees may be dead (class 5) in future examinations.

Black-headed Budworm Near Haines

A western black-headed budworm infestation was discovered at Chilkoot Lake near Haines in 1973. Although defoliation was not visible from the air, pupae and moths were conspicuous when the area was examined on the ground. There was an average of 44.9 budworm eggs per 18-inch branch sampled, and medium defoliation is expected in 1974.

MANAGEMENT IMPLICATIONS

A review of apparent management alternatives available for sawfly or budworm infestations follows.

Prevention

There is no practical means of preventing outbreaks of either insect in undisturbed old-growth stands. The possibility of compounding effects from industrial air emissions is being explored in the Ward Creek drainage.

Conversion of old-growth stands to younger stands could minimize sawfly damage if the percentage stand composition of hemlock was reduced. Sawfly outbreaks may also be less likely in young than in old-growth hemlock. The only historical outbreak that we have observed in young second-growth was in a 100 year-old stand at Jamestown Bay near Sitka. The budworm can cause appreciable defoliation in young as well as older trees.

Inaction

Severe defoliation by either insect results in growth loss, top-kill, and some tree mortality in older trees. Young trees often show greater ability to recover from the effects of defoliation.

Severe defoliation of hemlock by the budworm can result in permanent damage to 42 percent of trees above 11 inches d.b.h. 1/ That percentage consisted of 14 percent tree mortality, 5 percent three-quarter top-kill, 9 percent one-half top kill, and 14 percent one-quarter top-kill. The green stand before defoliation contained 42 trees per acre over 11 inches d.b.h. Stand impact data for spruce is less available. Effects of sawfly defoliation are being studied.

Utilization

Tree harvest does not remove a budworm or sawfly population but it can utilize top-killed and dead trees. Large old-growth trees are less able to recover from the effects of heavy defoliation than are younger more vigorous trees. Harvest of large diameter, dominant trees that have been heavily defoliated, is constructive from an entomological standpoint. These severely weakened trees would not be exposed to defoliation by insects in future population outbreaks.

1/ Downing, G.L. 1957. Western hemlock damage caused by the blackheaded budworm - Appraisal survey, Thayer Lake, Admiralty Island, Alaska. U.S.F.S. Alaska Forest Research Center, March 1957. 7 p. unpub.

Suppression

Reduction of defoliator populations is not warranted in many of our hemlock-spruce stands under present timber market conditions. Where socio-economic and environmental factors justify direct insect suppression, we usually consider parasite, predator, or pathogen introduction; attempts at stand manipulation; chemical insecticide application or an integration of these measures.

Introduction of insect parasites or predators depends on selection of organisms that will kill a sufficient percentage of a pest insect population. Introduction also requires knowledge of secondary ecological relationships that may result between introduced organisms, their pest hosts, and non-target insects. We know of no parasitic or predatory insects that could contribute enough to population regulation to warrant their introduction against the sawfly or budworm in coastal Alaska.

Stand manipulation takes the form of judicious tree harvest and is discussed under Utilization, above.

No chemical or biological insecticides are registered with the Environmental Protection Agency for use against the hemlock sawfly or the western black-headed budworm. A sequence of laboratory screening, field experimentation, and pilot testing are required to determine a material's effectiveness and environmental safety. We have cooperated with our Insecticide Evaluation Project at PSW in the screening of 13 chemical formulations against the sawfly and 5 against the budworm. Three of the 8 most effective chemicals against the sawfly were Gardona, Zectran, and Pyrethrin. Zectran and Pyrethrin were among the three most effective chemicals applied against the budworm. Pyrethrins are highly regarded for their environmental safety but some problems of stability under our damp coastal conditions remain. Further insecticide screening against the budworm in 1974 is planned.

A pathogen, *Bacillus thuringiensis (B.t.)*, is effective against certain moth larvae including species related to the western black-headed budworm. A proposal has been submitted for review by the WO for field experimentation of *B. t.* or Zectran in the Ketchikan Area in 1974. *B. t.* has come under greater consideration since the natural collapse of sawfly populations against which it is ineffective.

Natural Mortality Factors

Naturally occurring parasitic insects have contributed to the reduction of sawfly and budworm populations. Significant sawfly population declines in 1973 resulted from a naturally occurring fungus, *Entomophthora sphaerosperma*. Cool wet summer weather in 1973 delayed sawfly development, and by the end of the normal sawfly oviposition period in October, no eggs were found. Summer weather in 1973 may also have promoted insect disease incidence even though it discouraged an increase in parasitic insects. A warm dry summer may have an opposite effect, favoring parasites yet disfavoring insect disease. 2/

Insect Activity Expected in 1974

Light defoliation is expected from the black-headed budworm in 1974. Most of this activity is expected south of Sumner Strait. Hemlock sawfly defoliation is expected to be considerably reduced in 1974. Tree "browning" due to defoliation by insects may be less obvious in Ward Creek near Ketchikan.

2/ Unpublished data, Forestry Sciences Laboratory, Juneau.

TABLE 1. Comparison of highest hemlock sawfly or western black-headed budworm larval numbers observed in 1973 with numbers observed in previous years in southeast Alaska. [a]

Location	Number of larvae per 3-tree sample[b]					
	Sawfly			Budworm		
	1971	1972	1973	1971	1972	1973
Neets Bay	255	118	83	15	5	26
Polk Inlet	502	999+	807	9	136	892
McKenzie Inlet	999+	999+	596	8	30	285
Quiet Harbor, Etolin Is.	0	177	95	0	4	0
Saks Cove, Behm Canal	7	5	0	26	23	209
N. Arm, Moira Sound	4	423	36	7	6	271
Dora Bay	193	427	43	7	5	612
W. Arm, Cholmondeley Sound	113	46	87	27	111	664
Hatchery L.	197	500+	406	1	0	5
Stevenson Is.	999+	529	423	0	0	1
Thorne Is.	900	800+	435	0	1	2
Princess Bay, Behm Canal	500	488	999+	256	148	56
El Capitan Passage	300	258	622	0	0	0
California Cove	-	-	415	-	-	715

[a] Each of 104 remaining sample locations in southeast Alaska had less than 40 sawfly or budworm larvae in 1973.

[b] Population indicator samples taken from 3 trees per sample location.

TABLE 2. Numbers of hemlock sawfly and western black-headed budworm eggs at sample locations on Prince of Wales and Revillagigedo Island, October 1973.

Sample Locations	Mean no. of eggs per 18" branch		Expected tree damage in 1974[a]
	Budworm	Sawfly	
South Arm, Cholmondeley Sound	38.2	0	medium
West Arm, " "	11.5	0	light
North Arm, Moira Sound	5.2	0	light
Thorne Arm	1.3	0	light
Ward Creek			
turnout 0.3 mi. from Connell L. fork	9.3	0	light
1.1 mi. from parking lot, opposite wood pile	3.7	0	light
0.4 mile north of Ward L. parking lot	3.9	0	light
Ward L. nature trail	12.2	0	light
Ward Cr. 1.0 mi. from intersection of main road and Connell L.	8.4	0	light

[a] Tree damage estimates based on Silver, G.T. 1959. A method for sampling eggs of the black-headed budworm. J. of For. 57(3): 203-205.

Light damage indicates light defoliation, loss of needles on top third of tree crown up to 25% (1-26 eggs per 18" branch).

Medium damage indicates total defoliation up to 40% of crown. Top third of tree crowns heavily defoliated and tops bare as well as considerable tip defoliation on the lateral branches. Up to 70% of buds damaged. General browning visible from the air (27-59 eggs per 18" branch).

Heavy damage would indicate over 50% of total foliage lost, top third of crowns heavily damaged with complete top stripping. Clearly visible from the air by light red color and bare tips (60 + eggs per 18" branch).

TABLE 3. Number of western hemlock in 5 defoliation classes following defoliation by the hemlock sawfly and western black-headed budworm. Ward Lake, Ketchikan. October 1973 [a]

Defoliation class [b]	d.b.h. (inches) 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Tot.
1		1																																	1 1%
2	2	1																																	3 4%
3	4	1	2	1	1	1	4			1		1	1	1					1			1	1		1						1				23 31%
4	8	3	2	3	5	3	2	2		1	3	1		1	2	1	2	1			2		2						1	1				1	47 62%
5								1														1													2 3%
Tot.	14	6	4	4	6	4	6	3	0	2	3	2	1	2	2	1	2	1	1	0	2	2	3	0	1	0	0	0	1	1	1	0	0	1	76

a Data based on 4 1/5-acre permanent plots. Other tree species not tallied.

b Defoliation classes are:

1. Less than 25% of foliage absent. Crown has greenish appearance.
2. Foliage loss between 26% and 50%. Upper crown usually greenish brown.
3. Foliage loss between 51% and 75%. Upper crown and portions of lower crown mostly brown. Some top killing and tree mortality.
4. Foliage loss more than 75%. Entire crown thin and has a greenish-purple appearance. Green foliage present is primarily new growth. Top-kill and tree mortality is common.
5. Tree dead. No foliage. Cambium may be moist but is beginning to sour.

TABLE 4. Number of western hemlock in 5 defoliation classes following defoliation by the hemlock sawfly, western black-headed budworm, and saddle-back looper. Vicinity of Connell Lake, Ketchikan. October 1973.[a]

Defoliation class[b]	d.b.h. (inches)																																							
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	40	50	Tot.
1			1	1				1														1							1						1		6
2			1			2			1			1	1			1	1	1												1						1	11
3			1	3	1	5	2	2	1	1		1		2		2		1	1	1		2			1	1			2	1							31
4					2	1	2							1								1															7
5				2	1		3	2		1	1	1	1		1					1					1		1	1			1				1		19
Tot.			3	6	4	8	7	5	2	2	1	3	2	3	1	3	1	2	1	2		4			2	1	1	1	3	1	2				2	1	74

[a] see footnote a, Table 3.

[b] see footnote b, Table 3.